

# GB643579

Publication Title:

Electrostatic generating machines

Abstract:

Abstract of GB643579

643,579. Electrostatic machines. CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE. July 15, 1947, No. 18870. Convention date, July 17, 1946. [Class 35] A cylindrical type electrostatic generator enclosed in a gas-filled container 13 comprises a stator with an even number of part-cylindrical conducting segments 3, 4 and a rotor carrying outwardly facing part-cylindrical conducting members corresponding to those on the stator, the rotating conductors being divided into at least two longitudinally separated groups, each group forming a rotor of the machine, one providing excitation for the other. In the form shown, where two rotors are used, the conducting segments 7<SP>1</SP>, 8<SP>1</SP> provide excitation through brushes 11<SP>1</SP>, 12<SP>1</SP> for the stationary segment 3 which in turn influences the main rotor segments 7, 8, these being connected in turn by brushes 11, 12 to feed the other stationary segment 4 and the output lead 14. The insulating rotor cores 5, 5<SP>1</SP> supporting the rotor segments, also carry contact sectors 9, 10 and 9<SP>1</SP>, 10<SP>1</SP> respectively, these sectors being of substantially less angular extent than the rotor segments. The active edges of the stator and rotor segments are of rounded form and have a marginal thickness equal to at least two-thirds of the gas space between stationary and rotatable members. The capacity between rotor segments is reduced by using an insulator of low dielectric constant and cutting it away round the active edges. In a modification, the machine has two auxiliary rotors connected in succession and the machine may have several pairs of segments on the stator and rotor. Specification 637,434 is referred to.

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## PATENT SPECIFICATION

643,579



Date of Application and filing Complete Specification: July 15, 1947.

No. 18870/47.

Application made in France on July 17, 1946.

Complete Specification Published: Sept. 20, 1950.

Index at acceptance:—Class 35, D1.

## COMPLETE SPECIFICATION

## Electrostatic Generating Machines

We, CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE, of 13, Quai Anatole France (formerly called 13, Quai d'Orsay), Paris, France, a French 5 National Public Administration, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following 10 statement:—

The present invention relates to electrostatic generating machines and particularly to such machines having a small power.

15 In Specification No. 637,434 there has already been described an electrostatic machine comprising relatively movable conducting members the active parts of which, contrary to the machines heretofore built, have a substantial thickness, the shape of said parts being chosen so as to provide for a good distribution of the electrostatic field, i.e. so that the said field remains, at each point of the surface 20 of said parts, lower than or at most equal to the dielectric strength of the insulating medium in contact with said surface.

The present invention consists in an electrostatic generating machine comprising 25 a gas-tight casing containing a compressed gas of high dielectric strength within which are disposed a principal rotor and at least one auxiliary rotor which are rotatable relative to a stator 30 common to the rotors, said rotors each comprising an even number of part-cylindrical conducting segments which are movable relative to and face an even number of part-cylindrical conducting 35 segments forming the stator, and electric connections including brush contacts for alternately connecting the segments of the principal rotor to a point of the machine having a substantially constant potential 40 during normal operation of the machine and to an output lead, and simultaneously alternately connecting the corresponding aligned segments of the auxiliary rotor to one of the conducting segments of the

stator and to a point of the machine 50 having a substantially constant potential during normal operation of the machine.

According to a feature of the invention, the active edges of the segments of the principal rotor and the active edges of the 55 segments of the stator at least where they face the segments of the principal rotor, have a marginal thickness equal to at least two-thirds of the space between the segments of the principal rotor and the 60 stator when said segments are at least partially facing each other.

The invention also consists in an electrostatic generating machine comprising a frame formed of a pair of spaced 65 insulating flanges, stationary conducting members disposed between said spaced insulating flanges formed of an even number of part-cylindrical segments, a shaft rotatably mounted in said frame, at 70 least one core composed of an insulating material secured to said shaft and rotatable therewith, a main series of part-cylindrical segments equal in number to and facing the first mentioned stationary 75 part-cylindrical segments and disposed about said core and movable therewith, each of said main series of movable segments being connected to a corresponding conductive sector cooperating with an 80 even number of fixed brushes, a gas-tight metallic casing enclosing said machine, an insulated output lead passing through said casing, electrical connections between said casing and the alternate, odd-numbered brushes and between alternate, even-numbered brushes and said output lead, and at least one auxiliary series of similar part-cylindrical segments aligned with the main movable segments and 85 rotatable therewith but electrically separated therefrom, each of said auxiliary segments being connected to a corresponding conductive sector cooperating with another even number of fixed 90 brushes, the alternate odd-numbered brushes being connected with one of the stationary segments and the alternate

even-numbered brushes being connected to said casing, the active edges of the main movable conducting segments constituting a principal rotor and the active edges of 6 the stationary conducting segments, at least where they face the main movable segments, having a marginal thickness equal to at least two-thirds the space between a stationary conducting segment 10 and a movable segment of the principal rotor when said segments are at least partially facing each other.

Two embodiments of a machine according to the invention are described hereinafter with reference to the accompanying drawings, in which:—

Figure 1 is a diagrammatic longitudinal sectional view of a generating machine according to the invention and 20 comprising a single auxiliary rotor;

Figure 2 is a sectional view along the line II—II of Figure 1;

Figure 3 is a sectional view along the line III—III of Figure 1;

25 Figure 4 is a sectional view similar to that of Figure 1 of a machine comprising two auxiliary rotors;

Figure 5 is a sectional view along the line V—V of Figure 4;

30 Figures 6, 7 and 8 are partial transverse sectional views showing different suitable shapes for the stationary and movable conducting members of machines according to the invention.

35 The stationary parts of the generating machine comprise two flanges 1 and 2 made of insulating material and carrying conducting members or segments 3 and 4, of part-cylindrical shape made, for 40 instance of metal. Said conducting members delimit a cylindrical space inside which the rotating members are located. The latter comprise a main rotor which supplies the electric energy for the output 45 load and one or more secondary or auxiliary rotors fastened on the same shaft and supplying the electrical energy for the excitation of the machine.

The main rotor comprises an insulating member of cylindrical shape 5 fastened on a shaft 6 and carrying two outwardly facing conducting members or segments 7 and 8, of part-cylindrical shape, for instance, made of metal. Said 50 conducting segments which are the electricity conveyors of the machine are connected electrically with conducting sectors 9 and 10 on which rub conducting brushes 11 and 12, one of which is connected with 55 the body of the apparatus, consisting in a gas-tight metallic cylindrical casing 13 which is filled with compressed gas, and the other of which is connected with an insulated output lead 14 for collecting the 60 current supplied by the generating 65

machine. These electric connections are effected by conductors 15 and 16 which may be, for example, wires having a sufficient diameter.

The secondary rotor or rotors comprise 70 similar members, with a difference in size only, their dimensions being generally smaller. In the following description the corresponding members of the secondary rotors and of the main rotor will bear the same references which will be primed in the case of the secondary rotors.

75 One of the features of the invention resides in the fact that the stationary conducting members 3 and 4 and the conveyors 7 and 8 have, at least on their active edges, a marginal thickness at least equal to two thirds of the thickness of the layer of gas separating a stationary conducting member from a conveyor when two such members are at least partially face to face with one another and the difference of potential between said members has the highest value it can have during a normal working cycle of the machine. On another hand, in order to avoid unfavourable losses through sparks, brush discharges, corona and the like, the 80 said active edges are shaped, in a manner known *per se*, so as to provide for a good distribution of the electrostatic field, as above mentioned. The maximum power is thus obtained, which is determined by the respective capacities of the stationary and movable conducting members; the 85 dielectric strength of the compressed gas and the above mentioned gas thickness.

90 It will generally be advisable to give the stationary conducting members and the movable conducting members or conveyors a marginal thickness which is substantially equal to or larger than the above mentioned gas thickness, their active edges being, for instance, shaped as shown in Figure 6. Any thickness may 95 be chosen for the regions of the conducting members away from the edges. If this thickness is chosen smaller than the necessary marginal thickness it will be 100 necessary to thicken the member progressively as the active edges are approached, as shown in sectional view in Figure 7. If, on the contrary, the general thickness of the conducting members is chosen higher than the necessary marginal thickness, it 105 is sufficient to give the edges a favourable shape such as that which is shown in sectional view in Figure 8. These rules 110 relate, more particularly, to the main rotor and the stationary conducting members 3 and 4 in the regions where they are opposite said main rotor; when the auxiliary rotors are to supply only an 115 insignificant power, as is generally the case, it is not necessary that said rules be 120 125 130

applied strictly to the same. It will be necessary, however, to give the conveyors 7, 8, 7<sup>1</sup>, 8<sup>1</sup> a sufficient marginal thickness comparable with that which is given 5 to the main conveyors 7 and 8.

In the particular embodiment shown in Figures 1 to 3, the stationary conducting member 4 is connected to the delivery brush 12 by the wire 16 and to the insulated output lead 14 by a direct connection. Brush 12<sup>1</sup> is connected to the stationary conducting member 3 by the wire 16<sup>1</sup> and the two brushes 11 and 11<sup>1</sup> are connected to the casing 13 by the 15 wires 15 and 15<sup>1</sup>.

If  $2U$  is the maximum difference of potential which can exist, during a normal working, between the stationary conducting members 3 and 4 and the conveyors 7 and 8 when two of such members register at least partially, the stationary conducting member 3 is brought to a potential near  $\pm U$  and acts as an inductor while the other stationary member 4 acts 25 as a shield.

Under the influence of the stationary conducting member 3, the main conveyor 7 and 8 acquire charges during their rotation, through brush 11 and sectors 9 and 30 10, the sign of which is opposite to that of 3. The conveyors carry away said charges when the contact is broken between the sectors and the brush 11 and their potential then rises in absolute 35 value. They afterwards come into contact with the brush 12 through sectors 9 and 10 and transfer their charges to the output lead 14 through the conducting chain formed of the members 12, 16, 4 40 and 14, which transfer is promoted by the conducting member 4 serving as a shield, after which the cycle is repeated.

The auxiliary rotor works in the same manner, but, in this case, conducting 45 member 4 plays the part of an inductor inducing a charge on the conveyors 7<sup>1</sup> and 8<sup>1</sup> when the latter are connected to the casing 13 by the wire 15<sup>1</sup>, the brush 11<sup>1</sup> and the conducting sectors 9<sup>1</sup> and 10<sup>1</sup> 50 connected with the conveyors 7<sup>1</sup> and 8<sup>1</sup>, while the member 3 now plays the part of a shield promoting the discharge of the conveyors 7<sup>1</sup> and 8<sup>1</sup> and receiving the electricity carried by said conveyors, 55 through the brush 12<sup>1</sup> and the wire 16<sup>1</sup> which connects said brush 12<sup>1</sup> with the member 3. The secondary rotor thus constitutes, in a well known manner, an auxiliary generating machine which 60 maintains the charge of conducting member 3 with a supply of electricity which compensates the losses sustained by said member and, moreover, the whole machine is spontaneously electrified as 65 soon as it is rotated, thus insuring the

starting of the generating function.

It is advisable to give the conducting sectors 9, 10, 9<sup>1</sup>, 10<sup>1</sup> on which the brushes rub a convenient angular opening (i.e. the angle subtended by the sector at the 70 axis of rotation) and to give the brushes a convenient position in order that contact between the sector and brush will make, when the generating machine is in normal working action, at the moment 75 when the difference of potential between the sector and brush is near zero. Thus sparks are avoided which are unfavourable to the good preservation of the apparatus, as well as dissipation of electric 80 energy which is prejudicial to the efficiency of the generator. For obtaining this result it is advisable to give the sectors an angular opening of the order of half the angle subtended at the 85 machine axis by a conveyor, that is to say about 80° to 90°. When the stray capacities are comparatively important, as is the case more particularly in the auxiliary rotor, it is advisable to take a 90 smaller angular opening, 50° to 70° for example.

It is possible, without departing from the scope of the invention, to choose, for the stationary conducting members 3 and 4 and the movable conducting members 7, 8, 7<sup>1</sup> and 8<sup>1</sup> an angular opening different from 180° while always giving them a substantially cylindrical surface. It is possible, for instance, to give them an 100 opening of 180°/n with 2n stationary conducting members in all and 2n conveyors on the principal rotor. The stationary conducting members may be connected electrically two by two so as to form two 105 groups serving the same purposes as the segments 3 and 4. The same will be true for the conveyors of each rotor. It will be advisable to give the conducting sectors on which the brushes rub an angular opening of about 180°/n.

In the construction of the main rotor it is advisable to reduce as much as possible the stray capacities between shaft and conveyors as well as between the conveyors themselves, for said capacities reduce the power in an appreciable manner. To this end, it is important to use for the construction of the core 5 an insulating material the dielectric constant of which is as low as possible and preferably lower than 4 and to hollow out this insulator as much as possible consistent with its mechanical strength.

The generating machine shown at 125 Figures 4 and 5 comprises, besides the principal rotor formed of the core 5 and the conveyors 7 and 8, two auxiliary rotors formed respectively of the cores 5<sup>1</sup> and 5<sup>11</sup> and the conveyors 7<sup>1</sup> and 8<sup>1</sup>, on 130

one hand, and 7<sup>11</sup> and 8<sup>11</sup> on the other. The brushes 11 and 12 co-operating with the principal rotor are connected respectively, by wires 15 and 16, with the gas-tight conducting casing 13 and with the insulated output lead 14. The brushes 11<sup>1</sup> and 12<sup>1</sup> co-operating with the first auxiliary rotor are connected respectively, by wires 15<sup>1</sup> and 16<sup>1</sup>, with the 10 casing 13 and with the stationary conducting member 3. Finally, the brushes 11<sup>11</sup> and 12<sup>11</sup> co-operating with the second auxiliary rotor are connected respectively, by wires 15<sup>11</sup> and 16<sup>11</sup>, with the 15 casing 13 and with the stationary conducting member 4.

When the machine is in operation, the stationary conducting member 3 is brought to a potential of around  $\pm U$ , 20 while the other stationary member 4 is brought to a potential near  $\mp 2U$ . Under the influence of member 3 the conveyors 7 and 8 of the main rotor acquire through 25 sectors 9 and 10 and the brush 11 a charge the sign of which is the reverse of that of the charge of member 3. They carry said charge away when the contact with brush 11 is broken and then come into 30 relation with the brush 12 connected with the insulated output lead 14, transfer their charge through the latter to the output load, and then acquire from the same a charge of the opposite sign owing 35 to the influence of member 4. This charge is carried away by the conveyors 7 and 8 when their relation with 12 is broken and then transferred to the body of the machine through brush 11, and the cycle 40 is repeated.

The secondary rotors work in a similar manner. For one of them, the member 4 which plays the part of an inductor, inducing a charge on the conveyors 7<sup>1</sup> and 8<sup>1</sup> when the latter are connected with the casing 13 through brush 11<sup>1</sup> while member 3 plays the part of a shield for said conveyors; promoting their discharge when they are in contact with the brush 12<sup>1</sup> connected with member 3. This auxiliary rotor thus constitutes an auxiliary generating machine which maintains the charge of member 3 through a supply of electricity. For the 50 other auxiliary rotor, the member 3 plays the part of an inductor inducing a charge on the conveyors 7<sup>11</sup> and 8<sup>11</sup> when they are connected to the casing 13 through the brush<sup>11</sup>, while member 4 plays the part 55 of a shield promoting the discharge of the conveyors 7<sup>11</sup> and 8<sup>11</sup> when they are in relation with brush 12<sup>11</sup> connected with member 4. This auxiliary rotor thus constitutes a generating machine which 60 maintains the charge of member 4. It

would also be possible, instead of taking the charge of the conveyors 7<sup>11</sup> and 8<sup>11</sup> from the casing, to take it from the insulated output lead 14 of the generating machine. 70

It will be advisable, as in the previously described embodiment and for the same reasons, to give the conducting sectors 9 and 10 of the main rotor and the sectors 9<sup>1</sup>, 10<sup>1</sup>, 9<sup>11</sup> and 10<sup>11</sup> of the 75 secondary rotors on which the brushes rub a suitable angular opening. It is also necessary to give the brushes a convenient position in order that during the usual working of the generating machine the 80 contact between a sector and a brush is established at the moment when the potential difference between the sector and brush is near zero. In order to obtain this result it is advisable to give the 85 sectors of the main rotor an angular opening equal to about two thirds of the angle covered by a conveyor, that is to say, 110° to 120° in the case of Figures 4 and 5. As regards the sectors 9<sup>1</sup>, 10<sup>1</sup>, 9<sup>11</sup>, 10<sup>11</sup> of 90 the secondary rotors it will be necessary to give them a generally more reduced opening, more particularly when stray 95 capacities play an important part.

As previously, it will be possible to 100 use, without departing from the scope of the invention, a number of stationary conducting members and/or conveyors exceeding two. It will also be convenient to reduce, as much as possible, the stray 105 capacities of the main rotor.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we 110 claim is:—

1. An electrostatic generating machine comprising a gas-tight casing containing a compressed gas of high dielectric strength within which are disposed a 115 principal rotor and at least one auxiliary rotor which are rotatable relative to a stator common to the rotors, said rotors each comprising an even number of part-cylindrical conducting segments which 120 are movable relative to and face an even number of part-cylindrical conducting segments forming the stator, and electric connections including brush contacts for alternately connecting the segments of the 125 principal rotor to a point of the machine having a substantially constant potential during normal operation of the machine and to an output lead, and simultaneously alternately connecting the corresponding 130 aligned segments of the auxiliary rotor to one of the conducting segments of the stator and to a point of the machine having a substantially constant potential during normal operation of the machine. 130

2. Machine as claimed in claim 1, wherein the active edges of the segments of the principal rotor and the active edges of the segments of the stator, at least where they face the segments of the principal rotor, have a marginal thickness equal to at least two-thirds of the space between the segments of the principal rotor and the stator when said segments are at least partially facing each other.

3. An electrostatic generating machine comprising a frame formed of a pair of spaced insulating flanges formed of an ducting members disposed between said spaced insulating flanges formed of an even number of part-cylindrical segments, a shaft rotatably mounted in said frame, at least one core composed of an insulating material secured to said shaft and rotatable therewith, a main series of part-cylindrical segments equal in number to and facing the first-mentioned stationary part-cylindrical segments and disposed about said core and movable therewith, each of said main series of movable segments being connected to a corresponding conductive sector cooperating with an even number of fixed brushes, a gas-tight metallic casing enclosing said machine, an insulated output lead passing through said casing, electrical connections between said casing and the alternate, odd-numbered brushes and between alternate, even-numbered brushes and said output lead, and at least one auxiliary series of similar part-cylindrical segments aligned with the main movable segments and rotatable therewith but electrically separated therefrom, each of said auxiliary segments being connected to a corresponding conductive sector cooperating with another even number of fixed brushes, the alternate odd-numbered brushes being connected with one of the stationary segments and the alternate even-numbered brushes being connected to said casing, the active edges of the main movable conducting segments constituting a principal rotor and the active edges of the stationary conducting segments, at least where they face the main movable segments, having a marginal thickness equal to at least two-thirds the space between a stationary conducting segment and a movable segment of the principal rotor when said segments are at least partially facing each other.

4. An electrostatic machine according to claims 1, 2 or 3, including at least four stationary conducting segments and four movable conducting segments for the principal rotor and in which every other

pair of conducting segments belonging to the same group is electrically connected together, to provide that group with two functionally similar series of segments.

5. An electrostatic machine according to any of the preceding claims, in which the active edges of the principal movable conducting segments have a predetermined shape for maintaining the electrostatic field, at each point of the surface of said edges, not greater than the dielectric strength of the insulating medium in contact with said surface at said point.

6. An electrostatic machine according to any of the preceding claims, in which the active edges of the movable conducting segments have a thickness of the same order of magnitude as that of the principal movable conducting segments.

7. An electrostatic machine according to any of the preceding claims 3 to 6, in which the conducting sectors connected with each movable conducting segment are given such an angular opening, and the brushes such a position, that the contact between each sector and each brush is established at the moment when the difference of potential between a sector and a brush is near zero.

8. An electrostatic machine according to claim 7, in which there is only a single auxiliary rotor and in which the angular opening of the conducting sectors connected with each movable conducting segment is at most of the order of half the angular opening of the corresponding conducting segment and preferably less than said value when stray capacities are important.

9. An electrostatic machine according to claim 7, in which there are two auxiliary rotors and in which the angular opening of the conducting sectors connected with each movable conducting segment is at most of the order of two thirds of the angular opening of the corresponding conducting segment and preferably less than said value when stray capacities are important.

10. An electrostatic machine according to any of the claims 1 to 8 in which there is only a single auxiliary rotor, and in which the brush co-operating with the principal rotor and which is not connected to the body of the machine is connected to the output lead through one of the stationary conducting segments.

11. An electrostatic generating machine constructed and adapted to operate substantially as hereinbefore described with reference to Figs. 1, 2 and 3 of the accompanying drawings.

12. An electrostatic generating machine

120

125

constructed and adapted to operate substantially as hereinbefore described with reference to Figs. 4 and 5 of the accompanying drawings.

Dated this 16th day of July, 1947.  
BARON & WARREN,  
16, Kensington Square, London, W.8,  
Chartered Patent Agents.

Leamington Spa: Printed for His Majesty's Stationery Office by the Courier Press.—1950  
Published at The Patent Office, 25, Southampton Buildings, London, W.C.2, from which  
copies, price 2s. 0d. each (inland) 2s. 1d. (abroad) may be obtained.

Fig.1

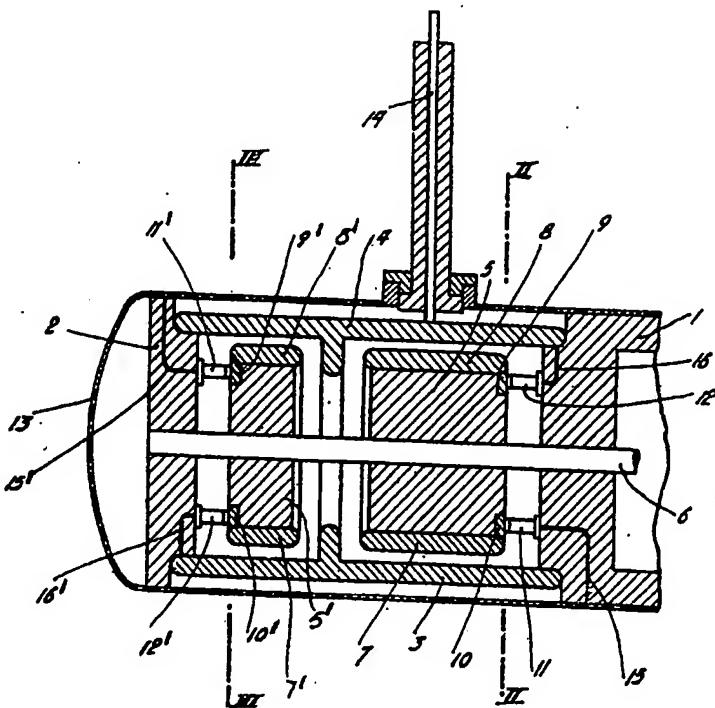


Fig. 2

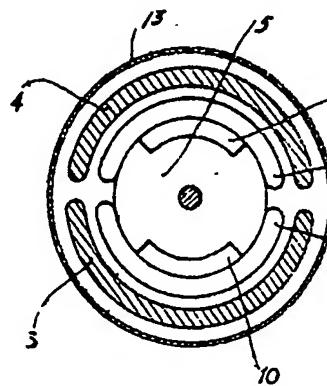
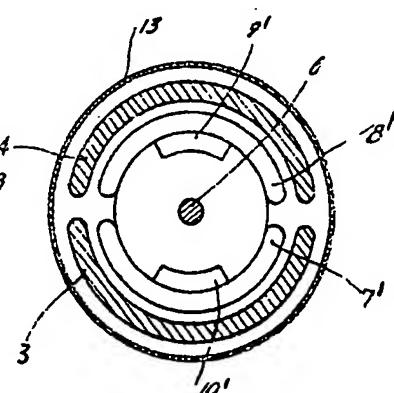


Fig. 3



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Fig. 4

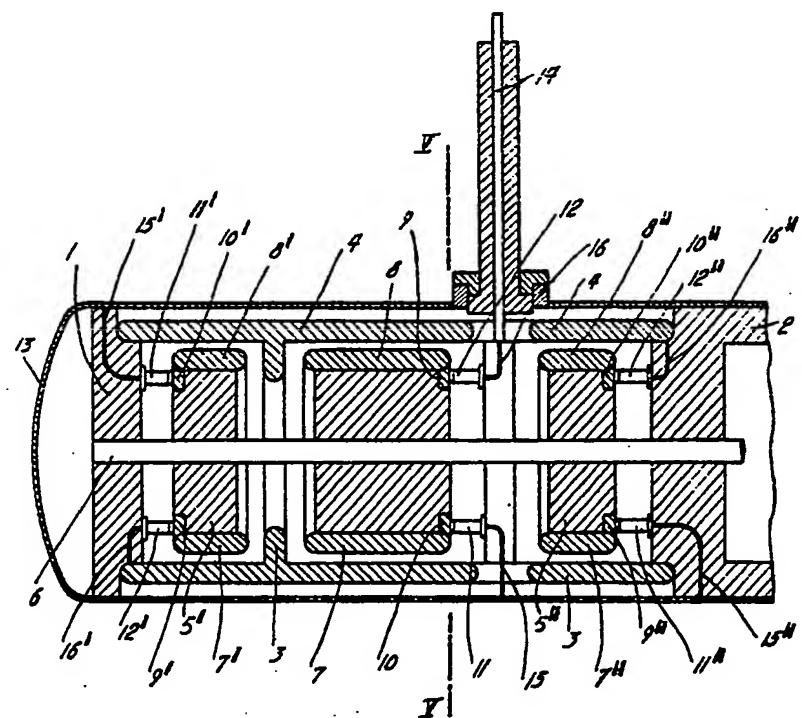
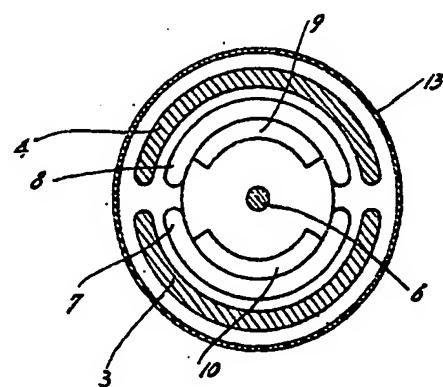


Fig. 5



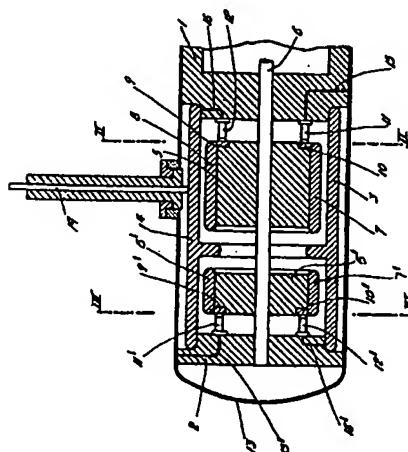


Fig. 1

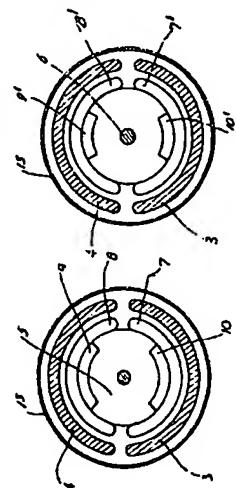


Fig. 2  
Fig. 3

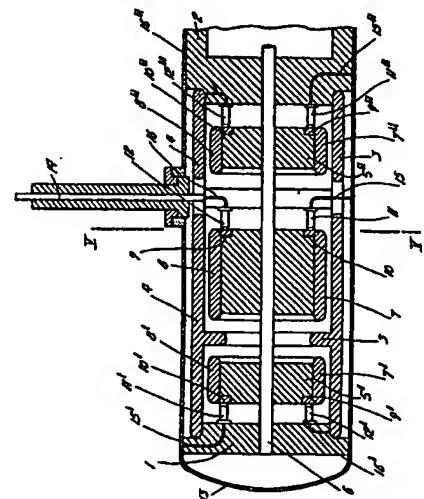


Fig. 4

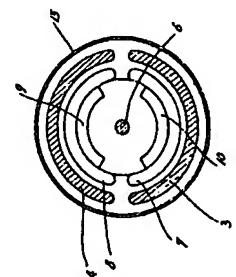


Fig. 5

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